I. C. 6696

MARCH, 1933

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

DREDGING METHODS AND COSTS OF THE ROSS ISLAND SAND & GRAVEL CO., PORTLAND, ORE.

RECEIVED
APR 10 1933
O. S. U. LIBRARY

BY

OTIS E. PERKINS

I.C. 6696
March, 1933.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

DREDGING METHODS AND COSTS OF THE ROSS ISLAND SAND & GRAVEL CO., PORTLAND, ORE.[1]

By Otis E. Perkins[2]

INTRODUCTION

This paper is one of a series being prepared for the United States Bureau of Mines to disseminate technical information regarding the methods used in mining nonmetallic minerals. The cost tabulations represent operating expenditures only and not total costs. It is recognized that publication of total costs might in many instances cause embarrassment to individual operators as well as to the industry as a whole. On the other hand, operating costs are essential to the technical discussion and study of the methods employed. The attention of the reader is specifically called to this differentiation in order that no misunderstanding of the scope of the cost tabulations shall ensue. This paper deals particularly with methods and costs of dredging, classifying materials, and transportation at the plant of the Ross Island Sand & Gravel Co. of Portland, Ore.

ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance of Harold Blake, general manager of the company, and of A. V. Kramer, cashier in charge of the plant office.

HISTORY

The Ross Island Sand & Gravel Co. was established in the fall of 1926. The company attracted a great deal of attention because it started operations in the Willamette River channel between two islands owned by this company and located 1½ miles upstream from the center of Portland. These two islands divide the river into three channels. The middle channel is the one from which the company gets its gravel, and is ideal for dredging in that a dike has been constructed between and at the upstream end of the islands which prevents driftwood and debris from entering the deposit. Figure 1 is a map of the property.

---

[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6696."

[2] One of the consulting engineers, U. S. Bureau of Mines, and superintendent, Ross Island Sand & Gravel Co.

Up until this time no sand was taken from the Willamette River by local companies, it was all barged in from points along the Columbia River. This meant considerable haulage cost in addition to a royalty charge of 10 cents a cubic yard on all materials taken from these rivers, which is collected by the States of Oregon and Washington.

GEOLOGY

The gravel deposit consists of the two islands and the channel between, covering an area of 385 acres. These islands were formed by changes in the river bed during past centuries. Dredging was started in the channel, which at low tide is practically uncovered. The reasons for starting at this point were the lack of overburden and the existence of a deposit of 30 feet of clean sand and gravel which runs 60 per cent of half inch and larger with 10 per cent of over $2\frac{1}{2}$ inch, and 40 per cent sand of which a high percentage is minus 28 mesh. There is a stratum of 2 feet of concrete gravel forming the natural bed of the river. Below this to a depth of 75 feet, which is the length of the ladder on the suction dredge, the material contains a high percentage of $2\frac{1}{2}$-inch and larger gravel and less sand.

As future needs demand, the islands themselves will be dredged. These islands are covered with 18 feet of sandy loam and a sparse growth of cottonwood and oak.

CHOICE OF METHODS

Before the construction of this plant began, H. Blake, the general manager, made a survey of various methods of reclaiming material from rivers all over the country. It was decided that the suction dredge fitted with a cutter head was the only practical equipment to use. The existence of stumps, sunken trees, and other debris in the deposit, in addition to strata of hard pan and small beds of blue clay, makes excavation difficult without some form of cutter operating ahead of the suction.

All gravel in the Willamette River at this location is basaltic, waterworn, and ranges in size up to 8 inches. On the other hand, sand of every size is found in abundance, all of which is irregular and hard, having a tensile strength of between 5,800 to 6,000 pounds per square inch on a 28-day mortar test, and having a specific gravity of 2.61.

METHODS OF PROSPECTING

Ten test holes were drilled at intervals on the property to a depth of 60 feet with a 6-inch casing.

Original from THE OHIO STATE UNIVERSITY

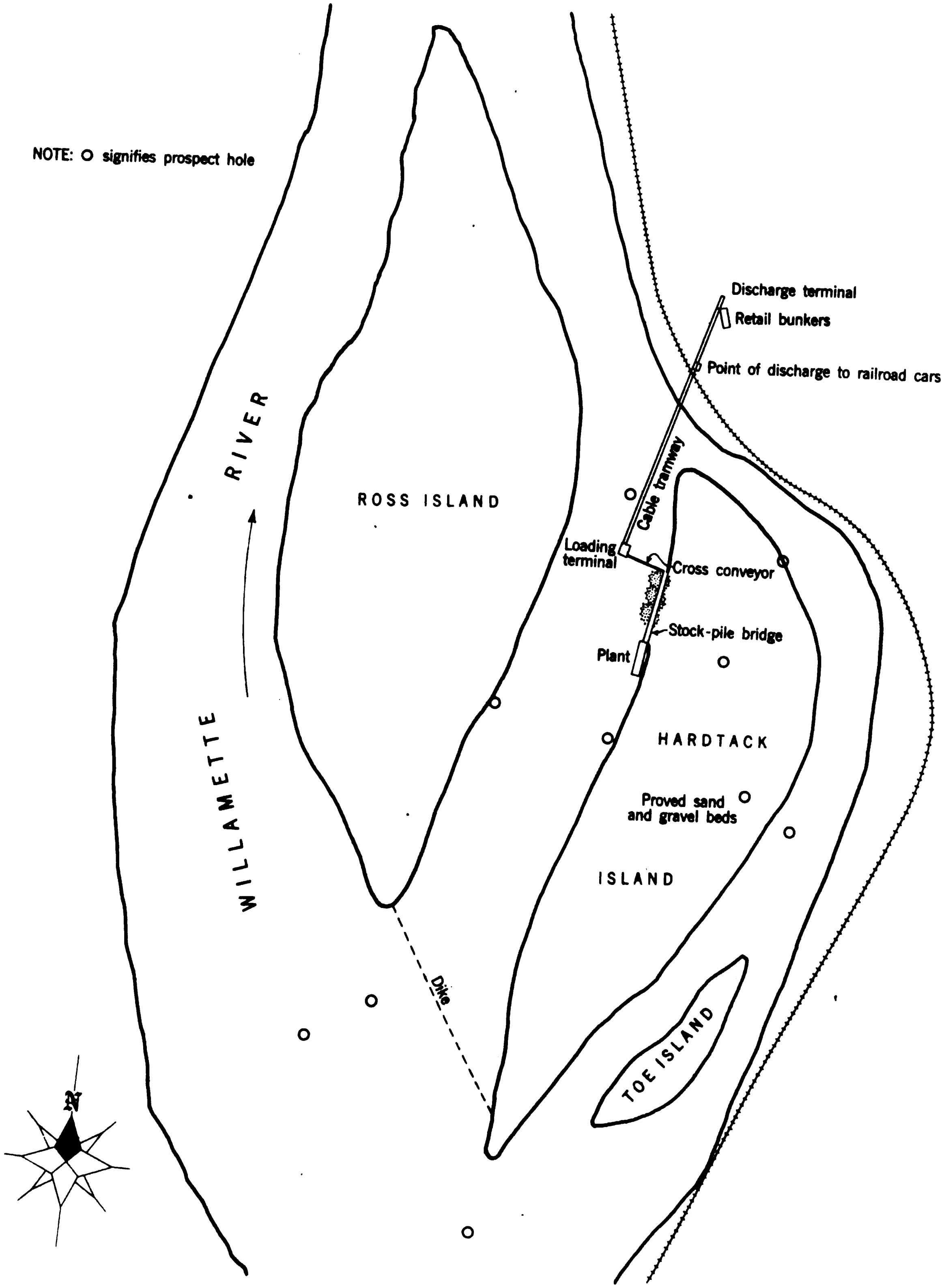

Figure 1.—Map of Ross Island property

DREDGE

When originally built the hull of the dredge was of unusually heavy timber construction stiffened with four longitudinal bulkheads and cross bracing. It was 80 feet long, 30 feet wide, and 5 feet deep, and carried a 50-foot ladder and cutter. In 1929 the length of the hull was increased 20 feet and the ladder lengthened to 80 feet. The deck and bottom are of 3-inch planking and the sides and bulkheads of 6-inch planking. All the machinery is inclosed by a cabin which is double sheathed for the first 4 feet from the deck and single sheathed for the rest of the way. The pilot house is forward on the second deck. The 12-inch dredge pump is direct-connected through marine-type thrust bearings to a 250-hp., 2,300-volt, 3-phase, 60-cycle, variable-speed motor. A 2-inch and a 3-inch centrifugal pump, direct-connected to a 5-hp. and a 25-hp. induction motor on a 440-volt current, supply water for priming the dredge pump and cooling the marine thrust bearing, and are also used for pumping bilge water and for fire protection.

The ladder is supported by means of a steel A-frame, carried on steel cables running over supporting posts and back to amidship. The ladder is raised and lowered by one drum of a 6-drum hoist, direct-connected to a 50-hp., 440-volt motor. The other five drums are used for swing lines in locating and anchoring the dredge. All carry 1,000 feet of cable; no spuds are used.

The cutter is driven by a 250-hp., 440-volt motor with a rope drive.

Electric power at 2,300 volts a.c. is delivered to the dredge by means of a lead-covered submarine cable carried on pontoons from the shore. The surplus cable is carried on a wooden reel with a 12-foot diameter and 8-foot face, and is provided with collector rings allowing the cable to pay off as needed. The 2,300 volts is used for the main pump. For the other small motors it is transformed by three 25-kv.a. transformers to 440 volts, with an additional 10-kv.a. transformer reducing 2,300 volts to 110 volts for a lighting circuit. The transformers are all inclosed in a flashproof metal tank on the roof of the dredge cabin. The metal tank has an automatic release ventilator and a 3-inch oil drain from the bottom, over the side, and down 1 foot under the water, for fire protection in case of a short circuit in the transformer.

In the pilot house the main pump control is of the drum type. Near it are controls for cutter, auxiliary pump, and the hoist. This arrangement enables one man to operate the entire dredge without assistance, except in case of trouble on the pipe line. The operator can then call for assistance by means of an electric siren on the dredge.

PIPE LINE

The discharge pipe is of 12-inch, high-carbon steel, made in lengths of 30 and 60 feet, with a manganese wearing ring at each joint facing the direction of flow of the gravel. The pipe is carried on two wood-stave pontoons which are 2½ by 12 feet long and fastened together by cross timbers. The pipe line is connected by rubber sleeves.

HOISTING

The pipe line comes in to the plant on a level with the dredge, and discharges into a 300-yard sump which provides sufficient capacity to allow for a short delay on either the dredge or in the plant. This sump is made of steel sheet piling and is so constructed that the surplus water may flow off over one side. The material is lifted by a 3-yard clamshell swung from an 85-foot boom on a steel stiff-leg derrick mounted on a platform of piling. The derrick has a 3-drum hoist connected by a rope drive to a 200-hp., 440-volt, variable-speed motor.

The gravel is partly washed in the digging operation. Silt and clay balls are partially broken up in the pipe line and all trace of foreign matter is removed by the rehandling in the sump and continued washing in the screens.

From the sump the material is lifted a distance of 90 feet, at low water, into a 30-yard hopper at the head of the screens.

SCREENING

The material is discharged from the hopper into a single 24 by 6 foot rotary screen which has two jackets, the inner one being 13 feet long and the outer 12 feet long. The inner screen has 16 feet of 1½-inch, square-punched openings at the feed end, and a 4-foot end section of 2¼-inch square opening at the discharge end; the first jacket has ½-inch round holes and the outside jacket is made up of woven wire with 3/16 by 7/16 inch openings. All the materials passing the 1¼-inch and retained on the ½-inch screen goes directly into two bins. All material passing the ½-inch and retained on the sand screen passes directly into two more bins. Sand is flumed from the screen across two sand cones through a slotted grid having openings of 1/8 by ½ inch in punched plate, in the bottom of the flume. The coarse sand is carried across the grid into two wheel classifiers.

Early operations of this deposit were by means of clamshell dredges, which dug cone-shaped holes in the bottom of the river. Later these holes became filled with fine sand and débris. In operating the 80-foot ladder, the uniform classification of sand was at first a big problem, but with the use of two wheel-classifiers this has been solved. These wheels are 8 feet in diameter and have 24 rectangular pans welded on the circumference. These pans are open at one side parallel to the main drive shaft. Each pan is 32 inches long, 4 inches deep, and 6 inches wide, and all are mounted at right angles to the plane of the center disk. The wheels are mounted in a wooden box with the sand entering one end of the box and the water overflowing at the opposite side. The important feature of the classifier is the possibility of regulating the speed to give any desired classification up to the coarsest paving sand. A 5-hp., variable-speed motor is used to drive the classifier through belt and gear reduction.

The gravel passing the 2½-inch screen goes onto a 24-inch conveyor belt carrying the material to the junction of four bins. Any overproduction can be crushed.

The varying sizes of commercial gravel, crushed stone, or sand fall into their respective bins, each with a capacity of 125 yards. The material may be drawn from these bins direct to barges or to a reclaiming belt system serving stock piles or an aerial tramway. The 24-inch by 300-foot reclaiming belt passes under the bins and discharges to either of two other conveyors. One of these is a horizontal, 300-foot-center, 24-inch belt with a tripper running the length of it, which discharges to the partly submerged stock piles. The other, a 20-inch by 250-foot cross conveyor, connects with the loading terminal for the aerial tramway. This tramway is used for loading railroad cars direct or for delivery to the bunkers for local trucks. These bunkers have a 1000-yard capacity, besides which there is an additional 2000-yard storage-pile system on the mainland.

AERIAL TRAMWAY

The aerial tramway is 1,800 feet long and has a capacity of 90 yards an hour. It has two timber suspension piers in the water and two towers on the mainland. At the terminal tower, which is of structural steel, the buckets are automatically dumped into a 10-yard hopper leading to an 80-foot vertical chute in the form of a pipe 13 inches in diameter. This pipe carries the material onto a mat and then into railroad cars under the tower. This tramway is of the continuous type and is driven by a 75-hp., 440-volt, constant-speed motor. The 21 buckets each have a 9/10-yard capacity and are automatically spaced by a timing device. The tramway loading terminal is of timber construction on a foundation of piling. The tension is put on the track cables by means of two concrete blocks weighing 60 tons on the empty side and 80 tons for the loaded cable. These blocks are fastened direct to the lines by large eyebolts and can rise or fall as the load comes on and off the lines. The tramway rises 100 feet from the loading point to the discharge terminal on the mainland.

STOCK PILES AND RECLAIMING SYSTEM

The gravel and sand in the main stock piles at the plant are loaded to barges by a steam clamshell digger with a 1½-yard bucket.

The barges are loaded direct from the bunkers by means of a 20-foot traveling conveyor belt 30 inches wide which moves along the face of the bunkers and draws material from any bin.

The foundation of the bunkers and plant are all built on a mat of piling 28 feet above the low-water mark. This is because spring freshets in the Columbia River cause floods in the Willamette River sometimes as high as 24 feet. As the islands are inundated at the high-water stage, it was necessary to build the plant on piling. This plan of construction also has the advantage of allowing the barges to be loaded direct from the bunkers.

The water for washing the gravel is drawn from the river by two deep-well pumps. One, a 10-inch pump with a capacity of 1,800 gallons per minute and driven by a 50-hp., vertical motor, is used for supplying wash water direct to the main screen; the other, an 8-inch pump with a capacity of 1000 gallons per minute and driven by a 40 hp., vertical motor, supplies water for washing sand and crushed gravel.

CRUSHING PLANT

All material over 2¼ inches, which is about 15 per cent, goes direct to a 24-inch by 60-foot conveyor belt connected by a roller chain and rope drive, which has a magnetic head pulley. The material goes into a bin of about 50-yard capacity and is there force-fed into a 10-inch gyratory crusher driven by a rope drive from a 75-hp., 440-volt variable-speed motor. This crusher is set at a 1½-inch opening; the discharge from it falls into the boot of an 18-inch by 86-foot, continuous-type bucket elevator discharging into a small hopper over a 4 by 6 foot, double-deck, vibrating screen. Any desired size separation can be made by using screens made up and kept in stock at all times. The screens range in size by eighths from 1/8 to 1½ inch openings. All are made of hard-drawn woven wire electrically welded on to their angle-iron frames, so that they are easily changed on short notice. The oversize from the screen flows into a 30-yard bunker, from there goes by a 24-inch by 40-foot conveyor to a 16-inch by 30-foot, continuous-type elevator, and is discharged into a bunker that in turn force-feeds a 7-inch Newhouse crusher. This crusher is direct-connected to a 60-hp., vertical motor. The crusher has an opening adjustable to the size of rock desired.

BUNKERS

The crushed-rock bunkers are 20 by 40 feet by 20 feet deep. They are divided into four equal bins. The material is drawn off by means of a 24-inch by 120-foot conveyor belt depositing material on conveyor belts leading to the storage piles or tramway.

The company has two retail bunkers. One of 1,200 yards capacity is located on the river bank opposite the plant and is served by the aerial tramway. The retail office is at this bunker and is centrally placed for truck deliveries in the southeast Portland district.

The other bunker is in North Portland on the Willamette River and is served by barge shipments from the plant, which is about 2½ miles distant. At this bunker the barges are unloaded by means of an electric hoist with a 1½-yard bucket which delivers into a small hopper feeding an incline conveyor belt which distributes material to the different bins through a tripper on the belt. The bins have a capacity of 600 yards.

POWER

The plant is operated entirely by electricity. Power is delivered to the plant at 11,000 volts, part of which is transformed into 2,300 volts and carried by submarine cable to the dredge, and the rest of which is stepped down to 440 volts for the plant proper. The transformers are mounted on the island adjacent to the plant. The power for the plant goes into a centrally located switch room which controls all the motors in and about the plant. All the motors are connected by short-center, V-shaped rubber belts, and where additional speed reduction is required, steel roller chains are used in strands of one or more according to the horsepower required.

MACHINE SHOP

All minor repairs are made at the plant machine shop which adjoins the plant. The equipment consists of a lathe with a 24-inch swing and 18-foot bed, a 24-inch radius drill, an emory wheel, a band saw, and a blacksmith forge and equipment. There is also a 300-ampere, electric-arc, welding machine and two acetylene welding and cutting torches.

EMPLOYEE PAY SYSTEM

The plant is operated on a 6-day week of 8 or 9 hours daily, depending on the yardage required and the season of the year. The average working year is 10 months. With the exception of the plant superintendent, all labor is paid on an hourly basis. Wages range from 50 cents to $1 an hour.

SAFETY METHODS

There is a well-equipped first-aid cabinet in the plant office, and another on the dredge. The superintendent acts as first-aid man in case of an accident.

Figure 2 shows the organization chart of the company.

Table 1.- Details of costs per cubic yard of sand and gravel

Period covered: 1928
Sand and gravel produced, cubic yards: 283,187
Average weight: Approximately 2,700 pounds per cubic yard

PLANT OPERATING EXPENSE

Operating costs	Labor	Supplies	Rent	Power	Repairs and maintenance	Depre- ciation	Insurance and taxes	Miscel- laneous	Total
Hydraulic dredging	$0.0145	$0.0016	-	$0.0268	$0.0416	$0.0096	$0.0088	-	$0.1029
Crushing and screening ...	.0194	.0051	-	.0283	.0366	.0269	.0217	-	.1380
Conveying and loading	.0083	.0006	-	.0044	.0033	.0072	.0039	-	.0277
Reclaiming loader (digger)	.0135	.0011	-	.0031	.0072	.0048	.0020	-	.0317
Superintendence	.0141	-	-	-	-	-	-	-	.0141
Stripping and clearing ...	.0005	.0008	-	-	-	-	-	-	.0013
Channel and stock piles ..	-	-	-	-	-	-	-	$0.0031	.0031
Towage	-	-	-	-	-	-	-	.0021	.0021
Watchman	.0067	-	-	-	-	-	-	-	.0067
Depletion	-	-	-	-	-	-	-	.0177	.0177
Sundry	-	-	-	-	-	-	-	.0014	.0014
Total	0.0770	0.0092	-	0.0626	0.0837	0.0485	0.0364	0.0243	0.3467

BUNKER OPERATING EXPENSE

	Labor	Supplies	Rent	Power	Repairs and maintenance	Depre- ciation	Insurance and taxes	Miscel- laneous	Total
Cubic yards handled (78,493):									
Bunker 1	0.0285	0.0060	0.0107	0.0029	0.0078	0.0140	0.0045	-	0.0744
Cable tramway	.0278	.0010	-	.0115	.0133	.0699	.0413	0.0038	.1686
Total	-	-	-	-	-	-	-	-	0.2430
Cubic yards handled (37,580):									
Bunker 2	.0929	.0042	.0981	.0182	.0233	.0463	.0388	.0050	.3268
Barging	-	-	.1706	-	-	-	-	-	.1706
Total	-	-	-	-	-	-	-	-	0.4974

Table 2.- Details of costs per ton of sand and gravel

Period covered: 1928
Sand and gravel produced, tons
Average weight: Approximately 2700 pounds per cubic yard

Operating costs	Labor	Supplies	Rent	Power	Repairs and maintenance	Depreciation	Insurance and taxes	Miscellaneous	Total
PLANT OPERATING EXPENSE									
Hydraulic dredging	$0.0109	$0.0012	-	$0.0201	$0.0312	$0.0072	$0.0056	-	$0.0772
Crushing and screening ...	.0145	.0038	-	.0212	.0274	.0202	.0163	-	.1034
Conveying and loading	.0063	.0004	-	.0033	.0024	.0054	.0030	-	.0208
Reclaiming loader (digger)	.0101	.0008	-	.0024	.0054	.0036	.0015	-	.0238
Superintendence	.0106	-	-	-	-	-	-	-	.0106
Stripping and clearing ...	.0004	.0006	-	-	-	-	-	-	.0010
Channel and stock piles ..	-	-	-	-	-	-	-	$0.0024	.0024
Tonnage	-	-	-	-	-	-	-	.0015	.0015
Watchman	.0050	-	-	-	-	-	-	-	.0050
Depletion	-	-	-	-	-	-	-	.0133	.0133
Sundry	-	-	-	-	-	-	-	.0010	.0010
Totals	0.0578	0.0068	-	0.0470	0.0664	0.0364	0.0274	0.0182	0.2600
BUNKER OPERATING EXPENSE									
Tons handled (105,966):									
Bunker 1	0.0214	0.0045	0.0080	0.0021	0.0059	0.0105	0.0034	-	0.0558
Cable tramway	.0209	.0007	-	.0086	.0100	.0524	.0310	0.0028	.1264
Total	-	-	-	-	-	-	-	-	0.1822
Tons handled (50,733):									
Bunker 2	.0697	.0031	.0736	.0136	.0175	.0347	.0291	.0037	.2450
Barging	-	-	.1279	-	-	-	-	-	.1279
Total	-	-	-	-	-	-	-	-	0.3729

Table 3.- Summary of production costs per ton of sand and gravel

	Labor	Supervision	Power	Supplies	Miscellaneous	Total
Stripping	$0.004	-	-	$0.006	-	$0.0010
Dredging	.0109	-	$0.0201	.0324	-	.0634
Crushing and screening	.0145	-	.0212	.0312	-	.0669
Conveying and loading.	.0063	-	.0033	.0028	-	.0124
Superintendence	-	$0.0106	-	-	-	.0106
Stock pile:						
In	-	-	-	-	$0.0039	.0039
Out	.0101	-	.0024	.0062	-	.0187
Sundry	-	-	-	-	.0060	.0060
Total operating ...	0.0422	0.0106	0.0470	0.0732	0.0099	0.1829
Depreciation	-	-	-	-	-	.0364
Insurance and taxes. ..	-	-	-	-	-	.0274
Depletion	-	-	-	-	-	.0133
Total	-	-	-	-	-	0.2600

Table 4.- Bunker and aerial tram costs per ton of sand and gravel

	Bunker 1	Bunker 2	Aerial transportation
Labor	$0.0214	$0.0697	$0.0209
Power	.0021	.0136	.0086
Supplies	.0045	.0031	.0007
Repairs and maintenance	.0059	.0175	.0100
Rent	.0080	.0736	-
Depreciation	.0105	.0347	.0524
Insurance and taxes	.0034	.0291	.0310
Miscellaneous	-	.0037	.0028
Barging	-	.1279	-
Total	0.0558	0.3729	0.1264

Cost per ton f. o. b. bunker 1 ...... $0.4422
Cost per ton f. o. b. bunker 2 ...... .6329

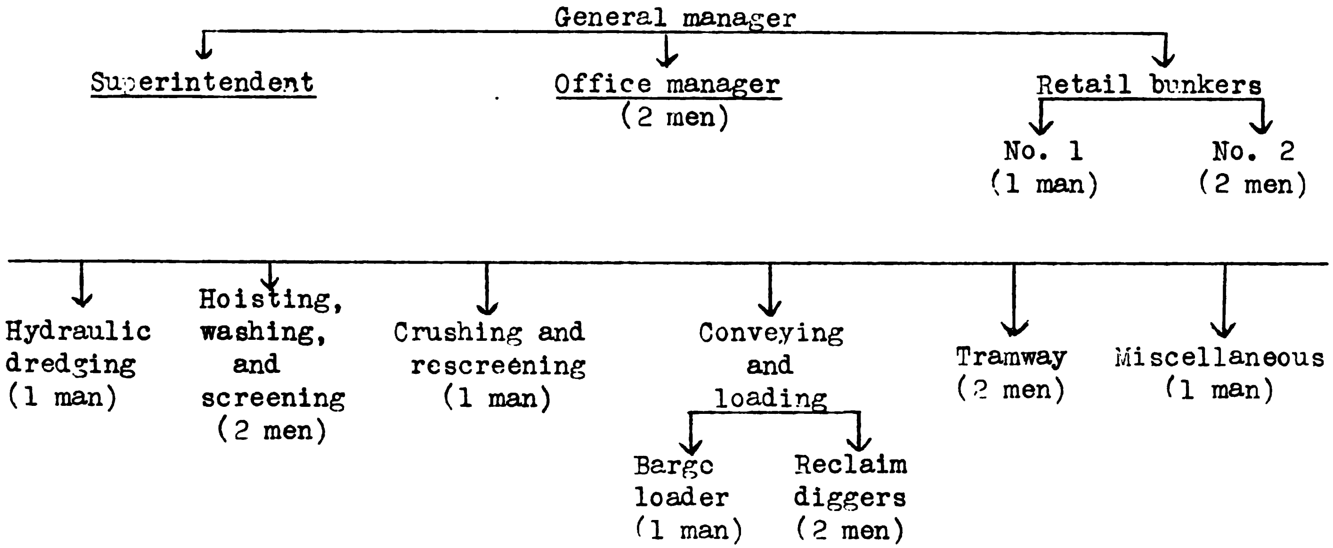

Figure 2.- Administrative organization chart

Original from THE OHIO STATE UNIVERSITY